

Meteorology 2017

Instructions:

Remember, you have 50 minutes, so use your time wisely. If you don't know the answer to a question, you may wish to skip it and go on. An announcement will go out when 30 minutes, 15 minutes, and 5 minutes remain. If you finish early, you may wish to check over your answers. You may use one 8.5 X 11" page of notes, front and back. If you have any questions, or are concerned about anything, please ask one of the event supervisors for help. Good luck and have fun! Remember to write your names and school in the blanks below.

Overview of Exam:

- Questions 1-20 will be multiple choice questions, each worth 1 point.
- Questions 21-30 will be free response questions, each worth different point values.
- There will be several tiebreaker questions scattered throughout the exam.

Remember that you do not have to do the questions in order. It is strongly encouraged that you do not spend an excessive amount of time on a single question, as you will only have 50 minutes.

Because the exam is graded on total points received rather than total questions answered, you do not have to complete all the exam questions to do well. Good luck!

This exam is worth 40 points.



Name: _____

Name: _____

School Name: _____

School Number: _____

Multiple Choice — each question is worth 1 point.

1. From September 9-13, 2013, Boulder, Colorado picked up 14.62 inches of rain, nine times its average monthly rainfall for September. Which of the following best describes why this happened?
 - a. a fast moving stationary front got caught in the jet stream, which was over the state of Colorado
 - b. remnant moisture from Hurricane Patricia stalled over the state of Colorado
 - c. the environment was unfavorable for lift, a factor that weakens severe weather development
 - d. an upper level low pressure center was stalled over the region, blocked by a dome of high pressure over the Pacific Northwest
 - e. the strong La Niña increased water temperatures in the central Pacific, allowing for bands of rainfall to come in through the west coast
2. Mammatus clouds, cellular patches of pouches that often extend from the base of a cloud, are often associated with which of the following cloud types?
 - a. cumulonimbus
 - b. cirrocumulus
 - c. asperatus
 - d. altostratus
 - e. lenticular
3. The Fujita Scale, a scale of tornado intensity, uses which of the following to determine its ratings?
 - a. wind speed
 - b. damage
 - c. central pressure
 - d. tornado size
 - e. distance of path
4. When the downdraft of a thunderstorm is stronger than the updraft, which stage is the thunderstorm in?
 - a. cumulus stage
 - b. dissipating stage
 - c. mature stage
 - d. alto stage
 - e. stratus stage

5. The most common form of lightning is
- a bolt from the blue
 - heat lightning
 - cloud to ground lightning
 - intercloud lightning
 - intracloud lightning
6. Lift can be most accurately described as
- the downdraft that causes a thunderstorm to dissipate
 - the formation of hail as it gets sucked into the raincloud
 - the trigger that initiates thunderstorm formation
 - the movement of cold air as it approaches a mountain
 - the inverted movement of cold and warm air on humid days
7. Floodwaters are most destructive in which of the following landscapes?
- grassy terrain
 - narrow canyons
 - small hills
 - rainforests
 - floodwaters are equally destructive along all landscapes
8. *(tiebreaker)* Over the past decade, hurricane prediction technology has vastly improved, allowing meteorologists to forecast hurricanes with greater accuracy. However, not all qualities of a hurricane are easy to determine. When forecasting a hurricane, which of the following aspects is often the most difficult to predict accurately?
- hurricane track
 - hurricane intensity
 - wind shear
 - water temperatures
 - dry air
9. The polar easterlies blow toward the
- west
 - east
 - north
 - south
 - equator

10. You observe a bolt of lightning and hear thunder 20 seconds later. How far away was the lightning bolt?
- a. 2 miles away
 - b. 4 miles away
 - c. 5 miles away
 - d. 10 miles away
 - e. 20 miles away
11. (*tiebreaker*) Air near the surface travels toward the equator while air in the upper atmosphere travels toward the poles. This describes which of the following cells?
- I. Polar Cell
 - II. Ferrel Cell
 - III. Hadley Cell
- a. I only
 - b. II only
 - c. III only
 - d. I and II only
 - e. I and III only
12. A purple line on a weather map containing both semicircles and triangles represents
- a. a cold front
 - b. a warm front
 - c. a stationary front
 - d. an occluded front
 - e. a squall line
13. Which factor most determines what a snowflake will look like?
- a. duration of storm
 - b. wind speed
 - c. wind direction
 - d. sunshine
 - e. temperature
14. Altostratus and altocumulus clouds typically predict
- a. fair weather
 - b. hot weather
 - c. cold weather
 - d. rainy weather
 - e. none of the above

15. Which of the following air masses is the most stable?

- a. Maritime Tropical
- b. Continental Tropical
- c. Maritime Continental
- d. Maritime Polar
- e. Continental Polar

16. Which of the following should you NOT do before a hurricane?

- a. seek shelter in the basement of your house
- b. board up windows and remove outdoor objects
- c. prepare a disaster kit for the house and the car
- d. have a NOAA weather radio handy with full batteries
- e. evacuate the area, if possible

17. (*tiebreaker*) Which of the following is most likely to experience flash flooding?

- a. a cornfield
- b. a forest
- c. a parking lot
- d. a prairie
- e. a soccer field

18. The National Weather Service uses which weather instrument to measure upper air data?

- a. compass
- b. pyranometer
- c. radiosonde
- d. ombrometer
- e. aerometer

19. What is the difference between a typhoon and a hurricane?

- a. typhoons have higher wind speeds
- b. hurricanes have higher wind speeds
- c. typhoons have lower central pressures
- d. hurricanes have lower central pressures
- e. none of the above

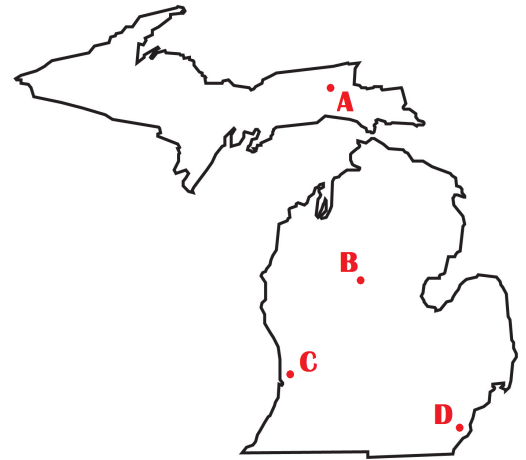
20. (*tiebreaker*) A person who has been struck by lightning

- a. should be administered CPR if he or she is unconscious and not breathing
- b. should not be touched for at least 60 seconds because of his or her electrified body
- c. should not be touched at all without proper protection gear
- d. has very little chance of survival
- e. should not be dealt with until emergency personnel arrive

Free Response

21. Karen lives in Buffalo, New York, a city stationed on the eastern shores of Lake Erie. Recently, the city received three feet of snow from continuous precipitation.

- a. What weather phenomenon did Karen most likely experience? *(1 point)*
- b. If this phenomenon were to occur in Michigan, in which of the following locations would it most likely happen? Explain your reasoning. *(2 points)*



22. Brandon lives in rural Iowa. One summer day, he looks up at the sky and sees a solid-looking, lowered area of rotating clouds above him. The clouds are firmly attached to the base of the thunderstorm.

- a. What is he most likely seeing? *(1 point)*
- b. In what type of thunderstorm is this feature normally found? *(1 point)*
- c. *(tiebreaker)* Two types of clouds can be found in thunderstorms: wall clouds and shelf clouds. Explain the difference between these two types of clouds with respect to their positions relative to the precipitation. *(2 points)*

Hint: which cloud points toward the precipitation, and which one points away?

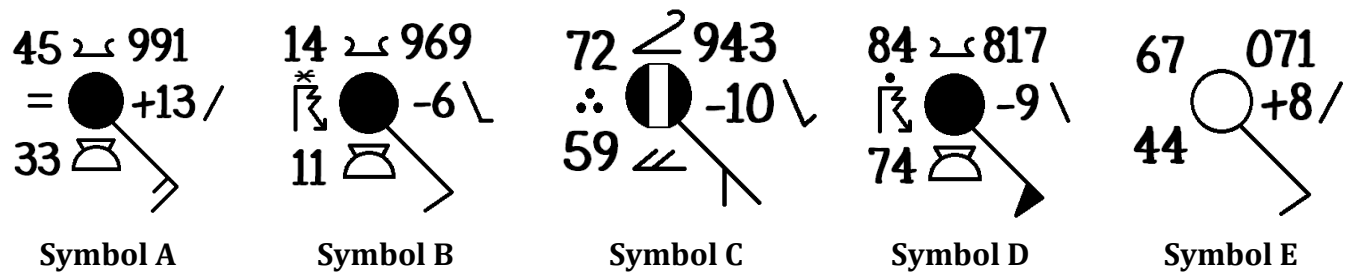
23. The following table lists the hurricane names for a hypothetical Atlantic and Pacific Hurricane season. Use it to answer to following questions.

No.	Atlantic	Pacific
1	Amanda	Adam
2	Brock	Becky
3	Cynthia	Carter
4	Derek	Diana
5	Estelle	Eric
6	Freddy	Felicia
7	Gina	Gregory
8	Hector	Helen
9	Isabelle	Isaiah
10	Jack	Joyce

- Suppose that a hurricane forms in the Atlantic basin in April, two months before the official start of the season. No storms have formed since November of the previous year. What would this hurricane be named? If the answer cannot be determined from the information given, write “cannot be determined.” (1 point)
- The first hurricane of the Pacific season was named Adam. What would the name of the second *hurricane* of the Pacific season be? If the answer cannot be determined from the information given, write “cannot be determined.” (1 point)
- What would the sixth named *storm* of the Pacific season be? If the answer cannot be determined from the information given, write “cannot be determined.” (1 point)
- (*tiebreaker*) On September 13th, Tropical Storm Jack formed in the Caribbean. Two hours later, another system developed a low-level circulation in the Atlantic, with winds exceeding 40 mph. If this storm were to be named, what would its name be? Note that any name that works will result in full credit. (1 point)

Hint: this name isn't on the chart — you'll have to come up with it!

24. Use the following symbols to answer the questions below (1 point each):



- Which of the following symbols represents the coldest temperature? _____
- Which of the following symbols represents a environment with fog? _____
- Which of the following symbols represents a sky with no cloud cover? _____
- Which of the following symbols represents a severe rainstorm? _____
- Which of the following symbols represents a 90% cloud cover? _____
- (tiebreaker) Which of the following symbols represents the highest pressure? _____

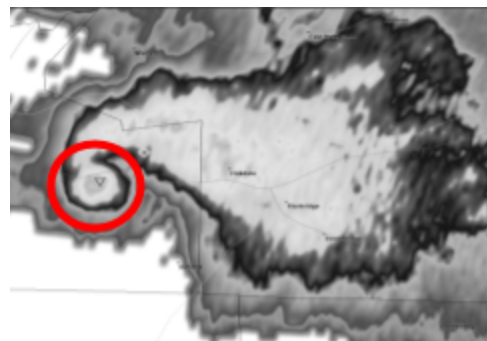
25. Hail develops in thunderstorms with very strong updrafts (winds that go straight up inside the storm). Hail starts as a very small piece of ice that travels upward inside the storm, where it captures water that freezes on contact making it bigger and bigger with time. The longer the time it stays in the areas of updrafts the bigger it can get. The closer the fall speed (how fast something falls to the ground) of the hail is to the updraft of the storm without being stronger, the more time the hail will spend inside the thunderstorm.

You can get a good idea of the fall speed of hail (how fast it falls to the ground) by knowing its size and using the following formula: $V = 10 \times D$ where V is the fall speed in meters per second and D is the size of hail in centimeters.

A thunderstorm just passed and you and your neighbor across the street find two big hail stones. You use a ruler to measure their size and find out that piece A was 4 centimeters and piece B was 6 centimeters.

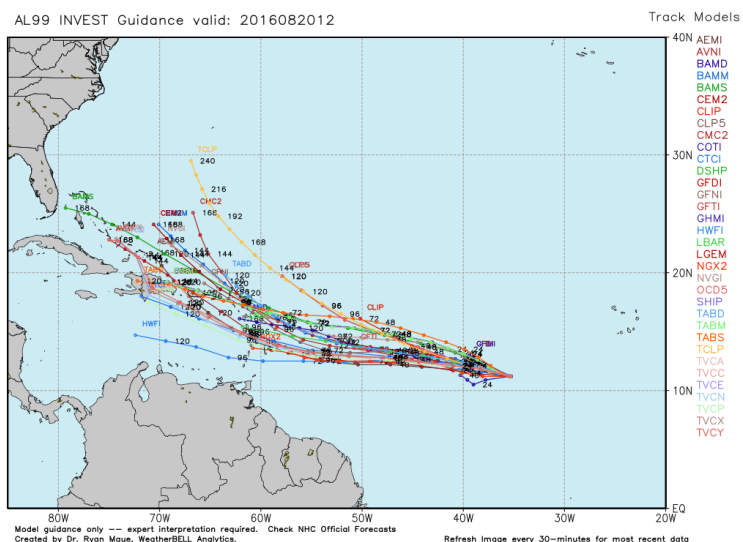
- What are the fall speeds of hailstones A and B? (2 points)
- Let's assume both hail stones are in the updraft of a thunderstorm with an updraft speed of 50 meters per second, which hail stone will probably stay in the updraft of the thunderstorm? (1 point)
- Assuming that the stones have not melted when you and your neighbor found them, which hailstone do you think spent more time inside the thunderstorm? (1 point)

26. This is a radar image of a tornado. What does the circled region represent? (1 point)



27. Here are the track and intensity forecasts for Invest 99L, a disturbance during the 2016 Atlantic Hurricane Season that later became Hurricane Hermine.

- a. (tiebreaker) On the spaghetti model to the right, draw out a possible cone of uncertainty. (1 point)



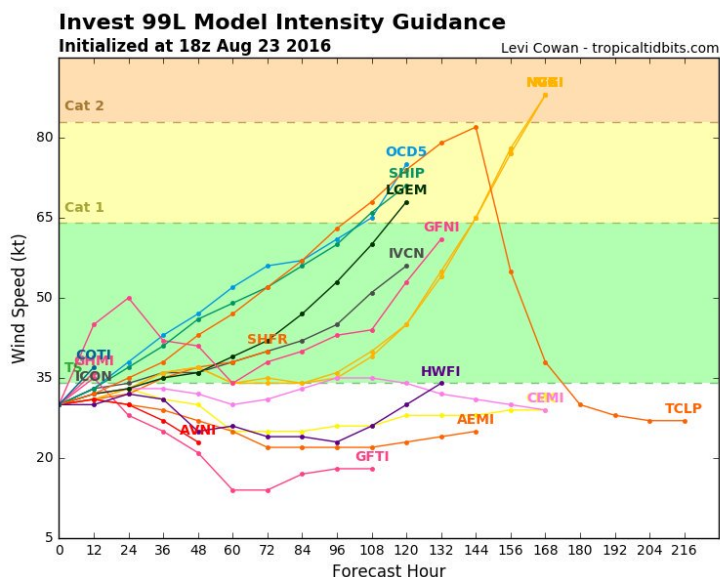
- b. (tiebreaker) How likely is it for Invest 99L to become a major hurricane within 120 hours?
Circle an option below. (1 point)

Unlikely

50/50

Likely

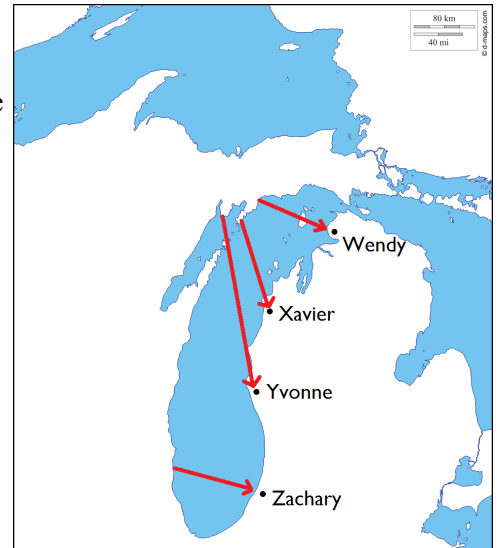
Explain your reasoning. (1 point)



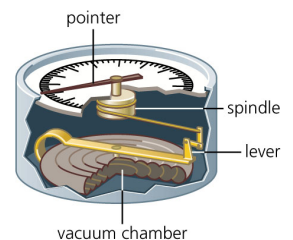
28. Lake effect snow occurs when cold air travels over warmer water. It picks up heat and moisture as it travels over the lake. This moisture then falls as snow as it reaches the shore. Considering the four paths over Lake Michigan in the diagram to the right and assuming that all factors other than travel path are equal for each situation, which student should expect the most snow? (1 point)

Wendy Xavier Yvonne Zachary

Explain your reasoning. (1 point)



29. Richard lives in the Southern Hemisphere. Use this information to answer the following questions.
- Will the air currents around a low pressure cyclone in the Southern Hemisphere move in a clockwise or counterclockwise direction? If the answer cannot be obtained with the information given, circle “cannot be determined.” (1 point)
- clockwise counterclockwise cannot be determined
- Will the air currents around a low pressure cyclone in the Southern Hemisphere move into or out of the center? If the answer cannot be obtained with the information given, circle “cannot be determined.” (1 point)
- into center out of center cannot be determined
- The following device measures air pressure. What is this instrument called? (1 point)



- (tiebreaker) Richard records a pressure of 969 mb at sea level using the device above. Is this a high pressure or low pressure system? If the answer cannot be obtained with the information given, write “cannot be determined.” (1 point)

Some helpful conversions: 969 mb = 28.61 inHg = 726.81 mmHg = 0.956 atm = 14.05 psi

Hint: The mean atmospheric pressure at sea level is 29.92 inHg.

30. Which satellite, GOES or POES, observes the same location on Earth at all times? (1 point)